
Quantifying the Disease Impact of Cigarette Smoking with SAMMEC II Software

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Tearsheet requests to Dr. Shultz.

Synopsis

Smoking-Attributable Mortality, Morbidity, and Economic Costs Software, Release II (SAMMEC II) has been developed for the Office on Smoking and Health, Public Health Service, to permit rapid

calculation of deaths, years of potential life lost, direct health-care costs, indirect mortality costs, and disability costs associated with cigarette smoking. For the mortality-related measures, age-specific and age-adjusted rates are also calculated. The pivotal epidemiologic measure in these calculations is the smoking-attributable fraction, an attributal risk measure.

A multiple-measure approach (attributable mortality and economic costs) to quantifying a health problem is termed "disease impact estimation." Previously, national and State-specific estimates of smoking-attributable mortality and economic costs were calculated using SAMMEC software, the predecessor of SAMMEC II. SAMMEC II is completely menu-driven and operates within the Lotus 1-2-3 software as a set of linked spreadsheets.

SAMMEC II adapts national epidemiologic methods for use by State and local health departments. Increased exposure of public health professionals to disease impact estimation techniques, as demonstrated by SAMMEC II, will lead to improvements in both methodology and the quality of smoking-related health data. The primary purpose of SAMMEC II, however, is to provide State or locality-specific data on the health consequences of smoking to policymakers and public health professionals in these jurisdictions.

THE CURRENT WORLDWIDE pandemic of smoking-related diseases reflects the legacy of the mass production and marketing of the addictive and lethal cigarette. Cigarette smoking extracts both human and economic costs and includes such dimensions as excessive rates of chronic disease and disability, diminished productivity, and premature death. These costs have been quantified by using measures from both epidemiology and health economics, such as smoking-attributable mortality, years of potential life lost (YPLL) (1,2), direct health care costs, and indirect costs (3). The term "disease impact estimation" is used for studies that produce a multiple-measure analysis of a health problem such as smoking (4).

Microcomputer software has been developed to perform disease impact estimation for diseases related to cigarette smoking. The software is entitled "SAMMEC II," the acronym for Smoking-Attributable Mortality, Morbidity, and Economic

Costs, Release II (5). SAMMEC II adapts the methodology used for national estimates of smoking-attributable disease impact (3) for use at State and local levels.

Methods

SAMMEC II performs a prevalence-based analysis of smoking-attributable mortality and costs of illness (3). Calculation of each of the principal disease impact measures relies on the prior calculation of the smoking-attributable fraction (SAF).

Smoking-attributable fractions. SAF is the proportion of cases of disease or deaths that can be regarded as causally linked to cigarette smoking. For each smoking-related diagnosis, the SAF represents the proportion by which the mortality would be reduced if exposure to cigarette smoking were eliminated. Once the population is divided into smokers

and nonsmokers, the SAF of a disease can be estimated by applying the following formula (6):

$$\text{Smoking-attributable fraction} = p(RR - 1) \div [p(RR - 1) + 1]$$

where:

p = percentage of smokers in the group under study

RR = risk ratio (relative risk) for smokers relative to nonsmokers

SAMMEC II software uses a calculation formula derived from this basic formula that accommodates three levels of smoking status—current, former, and never smokers (7):

$$\text{Smoking-attributable fraction} = \{ [p_0 + p_1(RR_1) + p_2(RR_2)] - 1 \} \div [p_0 + p_1(RR_1) + p_2(RR_2)]$$

where:

p_0 = percentage of never smokers in group under study

p_1 = percentage of current smokers in group under study

p_2 = percentage of former smokers in group under study

RR_1 = relative risk for current smokers relative to never smokers

RR_2 = relative risk for former smokers relative to never smokers

To calculate SAF values, diagnosis- and sex-specific relative risk estimates for smoking-related diseases and estimates of current and former smoking prevalence must be available. For a smoking-linked diagnosis, two relative risks are defined—the ratios of mortality rates for current and former smokers respectively—to the mortality rate for never smokers. The diagnosis list and relative risk estimates available in SAMMEC II are those reported in Chapter 3 of “Reducing the Health Consequences of Smoking: 25 Years of Progress” (8 and table 1). Smoking prevalence rates for the group under study are entered by the software’s user.

Disease impact measures: smoking attributable mortality, YPLL, and indirect mortality costs. SAMMEC II calculates three mortality-related measures of disease impact. During data entry, the user supplies numbers of deaths of men and women by 5-year age groups (ages 35–85 or older) for each smoking-related diagnosis. For four pediatric conditions, numbers of infant deaths (less than 1 year)

Design Features of the SAMMEC II Software

Hardware specifications: IBM PC/XT, PC/AT, PS2 or compatibles

Hard drive memory: 627 kilobytes (1 megabyte recommended)

Spreadsheet software: Lotus 1-2-3 Version 2.0 or higher

SAMMEC II menus (completely menu-driven design):

- “Seamless” integration of menus across all spreadsheet files
- User is restricted to the menu structure

SAMMEC II program control: all operations are directed by “macros” Lotus 1–2–3

SAMMEC II spreadsheet files (23 filename .WK1 files):

- Files are task-specific—
 - Data entry files
 - Disease impact calculation files
 - Data transfer files
- Files are linked—data arrays and codes are passed among spreadsheets automatically
- File retrieval is completely automatic

SAMMEC II graph files (24 filename .PIC files):

- Updated during calculation
- Printed using Lotus Print-Graph

SAMMEC II print files (2 filename .PRN files):

- Mortality data for males in ASCII format
 - Mortality data for females in ASCII format
-

are entered. For each age group and sex, deaths are then multiplied by the corresponding SAF value:

$$\text{Smoking-attributable mortality} = \text{Deaths} \times \text{SAF}$$

For smoking-attributable YPLL, an additional term is added to the product, the number of YPLL for that age of death:

$$\text{Smoking-attributable YPLL} = \text{Deaths} \times \text{SAF} \times \text{YPLL}$$

SAMMEC II permits calculation of YPLL prior to age 65 or YPLL prior to life expectancy, using age, race, and sex-specific life expectancy estimates. In analogous fashion, for smoking-attributable indirect mortality costs, the present value of future earnings (PVFE) for the age at death is substituted in the product. PVFE values are estimates of the amount of forfeited future earnings because of premature death from smoking-related causes, discounted to present-valued dollars (SAMMEC II options: 4, 6, or 10 percent discount rates, 9):

Table 1. Relative risk estimates for current and former smokers relative to never smokers for smoking-related diagnoses coded to the International Classification of Diseases, Ninth Revision (ICD-9-CM)

ICD-9-CM codes	Diagnoses	Males		Females	
		Current	Former	Current	Former
<i>Neoplasms</i>					
140-149	Lip, oral cavity, pharynx	27.48	8.80	5.59	2.88
150	Esophagus	7.60	5.83	10.25	3.16
157	Pancreas	2.14	1.12	2.33	1.78
161	Larynx	10.48	5.24	17.78	11.88
162	Trachea, lung, bronchus	22.36	9.36	11.94	4.69
180	Cervix uteri	NA	NA	2.14	1.94
188	Urinary bladder	2.86	1.90	2.58	1.85
189	Kidney, other urinary	2.95	1.95	1.41	1.16
<i>Cardiovascular diseases</i>					
390-398	Rheumatic heart disease.....	1.85	1.32	1.69	1.16
401-405	Hypertension	1.85	1.32	1.69	1.16
410-414	Ischemic heart disease:				
	Ages 35-64.....	2.81	1.75	3.00	1.43
	Ages 65 and older.....	1.62	1.29	1.60	1.29
415-417	Pulmonary heart disease.....	1.85	1.32	1.69	1.16
420-429	Cardiac arrest, other heart disease	1.85	1.32	1.69	1.16
430-438	Cerebrovascular disease:				
	Ages 35-64.....	3.67	1.38	4.80	1.41
	Ages 65 and older.....	1.94	1.27	1.47	1.01
440	Atherosclerosis.....	4.06	2.33	3.00	1.34
441	Aortic aneurysm.....	4.06	2.33	3.00	1.34
442-448	Other arterial disease.....	4.06	2.33	3.00	1.34
<i>Respiratory diseases</i>					
010-012	Respiratory tuberculosis ¹	1.99	1.56	2.18	1.38
480-489	Pneumonia, influenza.....	1.99	1.56	2.18	1.38
490-492	Bronchitis, emphysema	9.65	8.75	10.47	7.04
493	Asthma.....	1.99	1.56	2.18	1.38
496	Chronic airways obstruction	9.65	8.75	10.47	7.04
<i>Pediatric conditions ²</i>					
765	Short gestation, low birth weight.....	1.76		1.76	
769	Respiratory distress syndrome.....	1.76		1.76	
770	Respiratory conditions-newborn.....	1.76		1.76	
798.0	Sudden infant death syndrome	1.50		1.50	
<i>Other conditions</i>					
890-899	Burn deaths	(³)	(³)	(³)	(³)

¹ Respiratory tuberculosis, normally listed as an infectious disease, is included as a respiratory disease for SAMMEC II calculations.

² Perinatal conditions: deaths among infants under 1 year.

³ Smoking-attributable burn deaths from injury surveillance studies.

'SAMMEC II performs a prevalence-based analysis of smoking attributable mortality and costs of illness. Calculation of each of the principal disease impact measures relies on the prior calculation of the smoking attributable fraction (SAF).'

Smoking-attributable mortality costs = Deaths × SAF × PVFE

For all three measures, SAMMEC II calculates subtotals by diagnosis, by sex, and by age category (0-34, 35-64, and 65 or older) and the grand total

of all diagnoses for both sexes, for all ages combined.

Disease impact measures: smoking-attributable direct health-care costs. Direct costs are expenditures for preventing, detecting, diagnosing, and treating smoking-related diseases and medical conditions (3). For the group under study, the SAMMEC II user supplies total personal health expenditures and five component costs: hospitalization, physician services, medication costs, nursing home costs, and other professional services (3).

SAMMEC II calculations are based on two morbidity indicators, annual short-stay hospital days and annual physician visits, obtained from National Health Interview Survey (NHIS) (10) and unpublished analyses of 1989 NHIS data from the

Office on Smoking and Health (OSH). SAMMEC II incorporates separate relative rates of usage for these two parameters, based on the ratios of annual short-stay hospital days (or physician visits) for current and former smokers to annual hospital days (or physician visits) for never smokers. These rate ratios were calculated for persons reporting neoplastic, circulatory, or respiratory diseases to NHIS in 1987. SAMMEC II then computes SAFs by using these rate ratios as the relative risk terms in the SAF equation. These SAFs are next multiplied by the personal health care expenditures for the group under study to estimate smoking-attributable direct health care costs. The calculations are performed separately by type of cost, for example:

$$\text{Smoking-attributable hospitalization costs} = \text{Hospitalization costs} \times \text{Hospitalization coefficient} \times \text{SAF}$$

where:

$$\text{Hospitalization costs} = \text{User-entered hospital costs for group}$$
$$\text{Hospitalization coefficient} = \text{Fraction of national hospital costs for neoplastic, cardiovascular, and respiratory diseases (11)}$$
$$\text{SAF} = \text{Attributable fraction using relative rates based on hospital utilization by smoking status}$$

Disease impact measures: smoking-attributable indirect morbidity costs. SAMMEC II calculates indirect morbidity costs, the costs of lost productivity for persons who are disabled by smoking-attributable disease, by using a variation of the SAF formula. In this case, the relative rate terms in the SAF formula compare work-loss days for employed persons (or days confined to bed—"bed disability days"—for women keeping house) for current and former smokers relative to never smokers. These relative rates were developed using 1987 NHIS data (unpublished data, OSH, 1989). Average daily earnings are computed using participation rates in the labor force, mean annual income, and inputted values for housekeeping services for both nonemployed and employed men and women (3). Earnings are multiplied by average numbers of disability days to estimate total disability costs. Disability costs are in turn multiplied by SAF values:

$$\text{Smoking-attributable indirect morbidity costs} = \text{Average daily earnings} \times \text{Average disability days per year} \times \text{SAF}$$

Data Entry for SAMMEC II Software

Diagnosis list: based on reference 8

- Option to review diagnoses
- Option to add diagnoses

Data entry

Mortality data: user-supplied mortality data

- Diagnosis-specific
- Sex-specific
- 5-year age group-specific (ages 35–85 and older)
- Perinatal diagnoses included

Data entry options—

- Data entry using menu options
- Importing data from ASCII-format files
- Retrieving data stored in save files

Smoking prevalence rates: user-supplied smoking rates or U.S. rates from National Health Interview Survey (reference 10)

Relative risks: reference 8, based on Cancer Prevention Study II

Smoking-attributable fractions (SAFs): calculated values for SAFs

- Automatic calculation procedure
- Diagnosis-specific
- Sex-specific
- 5-year age group specific (ages 35–85 or older)

Population data

Group under study: User-supplied group population data

Standard population: user supplied population data or standard population options:

- United States, 1980 all races
- United States, 1980 whites
- United States, 1980 blacks
- United States, 1980 other races

Health care costs: user-supplied health-care cost data for—

- Total personal health expenditures
- Hospital costs
- Physician fees
- Nursing home costs
- Medication costs
- Other professional costs

Earnings data: user-supplied earnings data or U.S. 1985 earnings data

- Annual earnings
- Labor force participation rates
- Imputed value of housekeeping services

where:

SAF = smoking-attributable fraction using risk ratios based on work-loss days for employed persons and bed disability days for women keeping house

Table 2. Comparison of features of SAMMEC software and SAMMEC II software

Feature	SAMMEC	SAMMEC II
Menu structure	Partially menu-driven	Completely menu-driven
<i>Data entry</i>		
Diagnosis list	From reference 3, 1986	From reference 8, 1989, option to add diagnoses
Mortality data	User-supplied	User-supplied
Prevalence rates	United States, 1980, NCHS	United States, 1985, Current Population Survey
Relative risks	From reference 3, 1986, based on 8 cohort studies	From reference 8, based on CPS II
SAFs	Same SAF for all ages	Age-specific SAFs
Population data	Not available	Population data for group under study and options to select appropriate standard population for age-adjusted rates
Personal health expenditures	User-supplied	User-supplied
Earnings data	Not available	User-supplied
<i>Disease impact estimation</i>		
Mortality	Calculated measure	Calculated measure
Mortality rates	Not available	Calculated measure
YPLL	Calculated measure	Calculated measure
YPLL rates	Not available	Calculated measure
Mortality costs	Calculated measure	Calculated measure
Mortality cost rates	Not available	Calculated measure
Direct costs	Calculated measure from reference 11, 1984	Calculated measure, based on 1989 NHIS special analysis
Morbidity costs	Synthetically estimated from direct costs and mortality costs	Calculated measure based on 1989 NHIS special analysis
Summary costs	Calculated measure	Calculated measure
Per capita costs	Not available	Calculated measure

NOTE: NHIS = National Health Interview Survey; SAFs = smoking attributable fractions; YPLL = years of potential life lost; CPS II = Cancer Prevention Study II.

Description of Software

Design features. SAMMEC II is a microcomputer application that operates within Lotus 1-2-3, a spreadsheet software package that is commonly used by State and local health agencies (12). SAMMEC II is completely menu-driven, and 23 separate worksheet files are linked through the menus and command sequences. The menu structure is designed to be "seamless"; the user remains within the menu structure of the SAMMEC II application during the entire work session and never uses Lotus 1-2-3 commands. Controlling the program, operating the visible menu structure, retrieving the multiple worksheet files, and moving data and codes among worksheets are all coordinated by extensive "macro" programming.

Summary tables are printed during the work session, and the user never has to leave the SAMMEC II application. During program execution, SAMMEC II creates and saves 24 graph files for optional printing or plotting using the Lotus 1-2-3 Print-Graph function. Details of the design features are listed in the accompanying box on page 327.

Notes on data entry. SAMMEC II permits users to expand the diagnosis list. To add a diagnosis, the user is asked to supply ICD-9-CM codes, the name of the diagnosis, and relative risk values. SAMMEC II inserts the diagnosis into the existing diagnosis list in order by ICD-9-CM code and adds the diagnosis to the menu structure for entry of mortality data. Additional information on data entry is given in the accompanying box on page 329. SAMMEC II can accommodate separate relative risk estimates for ages 35-64 and 65 or older and separate smoking prevalence rates for every 5-year age interval for ages 35-85 years or older. In computing SAFs, the calculation is specific for diagnosis, sex, and age group.

Notes on disease impact calculation. SAMMEC II uses the same worksheets to calculate smoking-attributable mortality, YPLL, and indirect mortality costs (see accompanying box on page 331). For these measures, SAMMEC II also computes age-specific and age-adjusted rates.

Computational tables are "constructed" during the course of the calculations. To accommodate the variable length of the diagnosis list, these tables are erased at the end of the computation. Because

these tables exist only temporarily in random access memory, the worksheet files that construct these tables (.WK1 files in box on page 327) are moderate in size.

Discussion

Background. Epidemiologists and health economists have estimated the disease impact of cigarette smoking for the United States (1,3,8,13,14). Their findings strongly support the need for the prevention and control of smoking. Smoking control is decentralized in the United States for various reasons. Consequently, the development and enactment of smoking-control policies and prevention programs typically fall to State and local decision makers. State-based public health workers have been hampered by the lack of technical capability to produce locally relevant estimates of the disease impact of cigarette smoking.

To address this problem, microcomputer software (SAMMEC) was developed to generate rapidly measures of the impact of smoking-attributable disease (4,15,16). The software was used to produce national estimates of smoking-attributable mortality and YPLL for the United States (1). OSH distributed SAMMEC software to health professionals in all 50 States, Puerto Rico, and the District of Columbia in 1987 and, subsequently, State-based personnel calculated State-level estimates. Results were reported locally (17-19), and OSH compiled and published them (14, 20, 21). SAMMEC software was also used to produce estimates for all States in Australia (22), for the People's Republic of China (23), and for France (unpublished report by Catherine Hill and A. Giron, Institute de Gustive, Roussy, Paris, "Estimation du Nombre de Deces dus au Tabagisme, France, 1982"). SAMMEC-generated data have been used to support State-level smoking control legislation (24).

SAMMEC and SAMMEC II. In developing SAMMEC software, it was assumed that widespread and critical scrutiny of the software would lead to suggestions for improvements in methodology, health data systems, and ultimately, software features. SAMMEC II was designed in response to these suggestions and methodological advances. Table 2 compares the design features of SAMMEC and SAMMEC II. The spreadsheet format, selected for both SAMMEC and SAMMEC II, permits rapid updating of estimates as new data for the group under study become available.

Disease Impact Measures Calculated by SAMMEC II Software

Mortality: calculated measure

Mortality rates:

- Age-specific rates for 5-year age groups (ages 35-85 and older)
- Age-adjusted rates for age group 35 and older

Years of potential life lost (YPLL): calculated measure

YPLL rates:

- Age-specific rates for 5-year age groups 35-85 and older
- Age-adjusted rates for age group 35 and older

YPLL options:

- To age 65
- To age 75

Life expectancies—

- United States, 1985 all races
- United States, 1985 whites
- United States, 1985, blacks
- United States, 1985 other races
- User-supplied life expectancies

Indirect mortality costs: calculated measure

Indirect mortality cost rates:

- Age-specific rates for 5-year groups (ages 35-85 and older)
- Age-adjusted rates for age group 35 and older

Indirect mortality cost options: present value of future earnings (reference 30):

- United States, 1985 4 percent discount rate
- United States, 1985 6 percent discount rate
- United States, 1985 10 percent discount rate

Direct health care costs:

- Health-care cost data by diagnostic categories, based on reference 11
- Based on newly generated National Health Interview Survey data on medical utilization by smoking status (unpublished analyses from Office on Smoking and Health)

Indirect morbidity costs:

- Based on U.S. Bureau of Labor Statistics earnings data
- Based on newly generated National Health Interview Survey data on work loss and bed disability days by smoking status (unpublished analyses from Office on Smoking and Health)

Total economic costs:

- Sum of direct health care costs, indirect mortality costs, and indirect morbidity costs
 - Percentage distribution of costs
-

Current and future applications. SAMMEC II has been used to estimate the disease impact of smoking for Australia (25). In the United States, OSH has distributed SAMMEC II to all 50 States; State-level reports are beginning to appear (26). As this article goes to press, OSH has just published updated, race-specific estimates of smoking-attributable mortality and YPLL for the United States, produced using SAMMEC II (27).

Data generated by SAMMEC II may be used as one benchmark for measuring progress toward a smokefree society by the year 2000. Future estimations of the impact of smoking-related disease may include a broader range of epidemiologic and economic indicators (28). Methods for estimating the impact of disease will be applied to other lifestyle-related health behaviors, such as alcohol use and misuse (29, 30), by using similar software (31, 32). Other developments may involve the continued evolution of software products that can be used to estimate the disease impact of multiple lifestyle factors as they relate to the incidence of multiple diseases.

Conclusion

Disease impact estimation provides an important tool for developing public health strategies to confront the cigarette smoking epidemic. SAMMEC II software delivers this tool to the persons who directly translate data into policy and programs at the State and local levels.

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Problems in Estimating the Number of Women in Need of Subsidized Prenatal Care

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Tearsheet requests to Dr. Buescher.

Synopsis

For effective allocation of resources, public program planners need to know how many women require subsidized prenatal care and where they are located. Because sample surveys are expensive, indirect methods of estimation using secondary data sources are frequently used to arrive at quick annual estimates. Census data on poverty are often incorporated into such methods, but our study of the eight southeast States in Federal Region IV shows that available census data severely underestimate the proportion of pregnant women who are poor. Updated poverty data from the 1990 census will not solve this problem of underestimation.

Alternative methods for estimating the number of women in need of subsidized prenatal care services, for measuring unmet need, and for doing estimates on the county level are presented and evaluated. Such considerations are especially important, given the new Title V block grant reporting requirements.

TO ALLOCATE RESOURCES effectively, public prenatal care program planners must identify geographic areas with unmet need and estimate the number of women who require subsidized care. Since birth certificates in most States do not list family size and income as indicators of poverty, a variety of other methods have been employed to estimate the number of pregnant women at different poverty thresholds.

Some States have conducted special postpartum sample surveys in hospitals to gather a variety of data, including poverty level, not routinely captured through vital records. Some States participate

in an ongoing population-based surveillance of residents who recently have had a live birth. The Pregnancy Risk Assessment Monitoring System (PRAMS) is now operational in six States and the District of Columbia. Such surveys and ongoing surveillance activities provide valuable information to maternity program planners. But, to maintain usefulness, the surveys must be updated regularly. Periodic survey updates and ongoing surveillance activities are usually more expensive and time-consuming than most public programs can afford, and they generally cannot provide direct county-level estimates because of the restricted sample size.